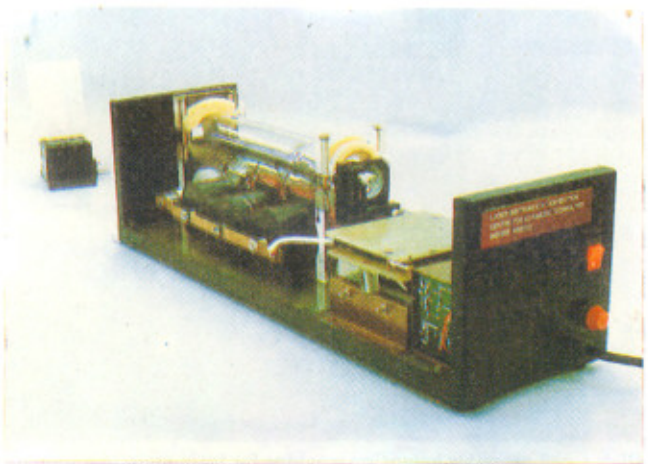
tigated in several laboratories worldwide. One nonlinear optical effect which appears promising for device application is optical limiting of nanosecond duration visible laser pulses in C_{60} solutions. Experimental and theoretical study of this phenomenon at CAT has led to a better understanding of the underlying physical mechanism. In C_{60}, absorption in the visible region results in excitation of the molecules to the long-lived triplet state. The absorption from this level is much stronger than that from the ground state and earlier it was believed that this 'reverse saturable absorption' is responsible for the observed limiting. The work at CAT has shown that this mechanism cannot fully account for the experimental observations and, in fact, a stronger role in the limiting action is played by induced scattering in C_{60} solutions. The scattering has been found to be laser fluence dependent and appears to be of thermal origin. Furthermore, nonlinear refraction in C_{60} solution, resulting from refractive index changes which can be due to heating and population transfer to the triplet state, has been shown to be important.

High resolution FIR and IR spectroscopy

A torsion-rotation-distorsion interaction Hamiltonian has been developed for symmetric and slightly asymmetric molecules capable of hindered internal rotation in a three fold potential barrier. The model has been successfully applied to the case of methyl alcohol, which is a slightly asymmetric molecule and is the best source of optically pumped FIR laser lines. The analysis has resulted in the interpretation of torsion-rotation and vibration-torsion-rotation high resolution Fourier transform spectra of methanol and some of its isotopic derivatives, e.g., $^{13}CH_3OH$, CD_3OH, $^{13}CD_3OH$, and CH_3OD. For the parent species the IR analysis resulted in the assignments and predictions of many optically pumped FIR laser lines. Of particular importance is the identification and prediction of FIR laser lines from the highly excited torsional states in the C-O stretch state. Using accurate combination loops the frequencies of the emission lines obtained to at least an order of magnitude better accuracy than can be obtained from direct wavelength measurements. This study of the FIR absorption spectrum (20 - 350 cm^{-1}) has resulted in an atlas of about 20,000 precise line positions with an accuracy of about 5 MHz. This atlas has been identified by the Journal of Molecular Spectroscopy as a secondary wavenumber standard in the FIR region.



Sealed-off nitrogen laser developed at CAT.

The study on the other isotopes of methanol has made it possible to interpret their laser Stark spectra and double resonance spectra. A Coriolis interaction model has also been developed for the perturbation observed in the excited vibrational state and to identify and predict many optically pumped FIR laser lines. The laser Stark study has provided accurate dipole moments and zero field transition frequencies in the ground state. Accurate molecular parameters are obtained for these isotopes. The interaction model was also applied in the case of a molecule with symmetric framework (ethane-D_3) to interpret the weak and complicated spectra in the three lowest torsional states and the molecular parameters were determined. These results will be useful for finding new emission lines with the optically pumped FIR laser being developed at CAT.

ACCELERATOR PROGRAMME

RF ion source

A radio frequency (RF) ion source has been developed for a 150 keV ion implantor. This ion source is capable of providing any gaseous ion. An indigeneously developed RF power source that operates at a frequency of 189.7 MHz has been used for this purpose.

The RF source consists of a quartz tube (44 mm diameter, 200 mm length) with a tungsten electrode fused at one end. The extraction potential is applied to this electrode. To prevent damage to this electrode from the electrons, a perforated quartz shield is provided. On the other end of the quartz tube an extraction port, having a highly polished aluminum canal with an aluminum collimator, is fixed. This assembly is housed in a stainless steel jacket which is insulated from it by a ceramic ring. The gas is fed into the source using a fine control needle valve. The RF power is transferred to the quartz tube by a capacitive coupling via an RF-matching network. The capacitance can be varied from 0 to 8 pF. Focusing of the ions at the extraction port is achieved by a solenoidal field.

Helium and argon ions have been extracted using this source in the pressure range 10^{-2} to 10^{-5} mbar. The RF

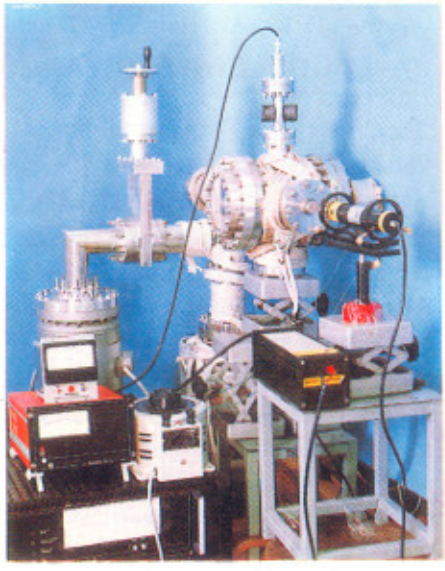
Cover: *Scanning electron micrograph showing surface topography of porous silicon.*

power was varied from 5 to 160 Watts. The maximum current obtained for argon-and helium ions was 2.5 mA at 4 kV and 1.5 mA at 1 kV respectively. The axial magnetic field was varied from 0 to 100 Gauss. Such an ion source will also be used for injection into the proton linac using hydrogen gas plasma.

Synchrotron radiation beam viewer

In a synchrotron radiation (SR) beam line, a beam viewer is an important module to carry out beam alignment after every optical element. A beam viewer comprising a novel electromagnetically operated flipping mechanism has been designed and developed for operation in an ultrahigh vacuum chamber. The flipping mechanism rotates a fluorescent screen by 45° to bring it in the path of the synchrotron radiation beam. The beam position is then monitored using a closed circuit TV camera placed at right angle to the SR beam path.

The flipping mechanism, driven by an electromagnetic actuator, consists of a stainless steel cantilever rod which is rotated by a plunger made of a soft magnetic material. This plunger moves in a stainless steel cylinder because of the electromagnetic force induced by an induction coil placed concentric with the stainless steel cylinder. The magnetic force pulls the plunger in such a way that the fluorescent screen makes an angle of 45° through mechanical limiting of its motion. The actuator along with the screen is mounted on a standard conflat flange which is fixed on to the beam viewer chamber. The beam viewer has been tested down to a vacuum of 8×10^{-9} mbar.



Synchrotron radiation beam-viewer with electromagnetic actuator.

Compact Faraday cups

The most widely used device for measuring electron or ion beam currents is the Faraday cup, which stops the beam completely. Compact water-cooled Faraday cups have been fabricated to measure the pulsed electron beam currents from a linac electron gun. A 40 kV, 100 mA, 2.6 μsec pulsed beam at 1 Hz corresponds to a power dissipation of a few milliwatts only. Pulsed currents were measured using a toroidal current transformer. The number of turns and the load resistance were matched to get a 1 mV signal for 1 mA beam current without affecting the time structure of the beam. In addition, high power water cooled Faraday cups have also been developed, and tested with a continuous beam of 2 kW power from a high voltage, high current electron gun (60 kV, 30 mA). Effects arising from sputtering, space charge, secondary particles and contact potentials have been taken into account during the design. A batch of three Faraday cups have been designed, fabricated and tested for electron beams in both pulsed and continuous modes.

Dynamic balancing machine setup for turbo-molecular pumps

A turbo-molecular pump is an efficient device for creating ultrahigh vacuum of the order of 10^{-9} mbar. CAT has taken up the development of a 150 litre/sec capacity turbo-molecular pumps.

The critical areas of the development of a turbo-molecular pump are mainly the fabrication of a complex geometry multistage finned rotor, stator, a three phase electric motor, a variable frequency power supply and the precision dynamic balancing of all the rotating components upto the operating speed of 50,000 rpm. A dynamic balancing machine satisfying our specifications has been developed for the first time in India by a private balancing machine manufacturer. The machine has been accepted and commissioned at CAT.

The set-up consists of two balancing machine modules. The first is a hard bearing type of balancing machine which will be utilized for low speed component balancing of various components such as motor rotor and the pump rotor separately. At low speed balancing the gross unbalance which is usually introduced by the size variation and machining tolerances, is minimised. The components are balanced upto a maximum of 6,000 rpm

High-speed-assembly balancing machine for turbomolecular pump.